THURSDAY, APRIL 27, 1916.

ANCIENT HINDU SCIENCE.

The Positive Sciences of the Ancient Hindus. By Dr. B. Seal. Pp. viii+295. (London: Longmans, Green and Co., 1915.) Price 12*s*. 6*d*. net.

A CHARACTERISTIC feature of the present-day literary activity of the philosophically minded men of science in India is seen in the commentaries they are publishing from time to time on their ancient systems of scientific doctrine, partly, no doubt, with the object of enlightening Western nations concerning the existence in these systems of certain root-ideas which are usually held by us to be the product of Western thought alone. The more our knowledge grows the more certainly will it be seen that many of these fundamental concepts are common to all systems of philosophy, and that, in the absence of an accurate chronology, it becomes increasingly difficult to determine where or with whom their germs originated. It is possible, of course, that some of these fundamental ideas were independently conceived, but it is equally probable that they may have had a common origin or have been radiated from a common source. In such case there is ground for the supposition that this common source was India. But in reality it is impossible to say with any approach to accuracy how Eastern knowledge travelled in the far-off times to which we are referring. We can only surmise that these ancient philosophies found their way along trade routes through Persia, Mesopotamia, Syria, to the Greeks and Egyptians, and thence along the Mediterranean littoral into Spain and western Europe.

In the book before us Dr. Brajendranath Seal makes no exaggerated claim to the antiquity of the body of knowledge with which he deals. Indeed, he says in the present state of Indian chronology it is impossible to assign dates to the original sources from which his materials have been drawn. Practically, he thinks it may be assigned to the millennium 500 B.C. to 500 A.D., which is comparatively late in the history of human thought. With respect to the West all he definitely asserts is that the Hindus had, if not a prior claim, at least an independent share with the Greeks in the work of constructing scientific concepts and methods in the investigation of physical phenomena. Indeed, it is probable that they were earlier than the Greeks in accumulating a body of knowledge capable of being applied to industrial technique. It is at least certain that Hindu scientific ideas deeply influenced the course of natural philosophy in Asia—in China and Japan towards the east and in the Saracen empire in the west.

The book under review consists of a series of monographs on the positive sciences of the ancient Hindus. Some portion of it has already appeared in Dr. P. C. Râ̂y's "Hindu Chemistry," viz., the chapters dealing with the mechanical, physical, and chemical theories of the ancient Hindus and with their scientific methods. The author regards his book as preliminary to a more comprehensive work on comparative philosophy, since philosophy in its rise and development is necessarily governed by the body of positive knowledge preceding or accompanying it. Hindu philosophy, he considers, on its empirical side was dominated by concepts derived from physiology and philology, whereas Greek philosophy was dominated by geometrical concepts and methods. The ultimate object of his labours, apparently, is to attempt a comparative estimate of Greek and Hindu science, with, it is hoped, a measure of success and some approach to finality.

Dr. Râ̂y's work on "Hindu Chemistry" has already been the subject of notice in these columns. On the present occasion, therefore, we purpose to restrict ourselves to an examination of the chapters dealing with Hindu ideas on kinetics and acoustics; on plants and plant-life; on the classification of animals; and on Hindu physiology and biology.

To begin with, a Western student of the book meets with an initial difficulty in the different systems of transliteration adopted by the two contributors. It is to be hoped, in the interests of uniformity, that if Western literature continues to be augmented by Eastern contributions of this character some understanding on this matter may be arrived at. It is difficult enough as it is for the Western mind to assimilate Eastern thought, or to appreciate its subtle *nuances,* without the difficulty being unreasonably increased by a matter which is surely capable of satisfactory settlement by philologists. A more serious difficulty consists in the employment by the author of terms like "isomeric," "polymeric," etc., which are essentially modern, and used by us in a perfectly definite sense to express modern ideas, but which in the book are adopted to connote conditions which are only very remotely analogous. Dr. Brajendranath Seal is well aware of what he admits is a questionable freedom. It would be difficult in all cases to suggest an alternative, but it must be admitted that the loose use of well-defined modern terms to express vague or only very distantly related ideas does not conduce to accurate thinking.

The chapter on mechanics deals with ancient Hindu ideas of the analysis of motion; of motion considered in relation to its causes; of motion not due to material contact of which the mechanical causes are unknown, and which are to be ascribed to the universal final cause (Adrista), *e.g.*, the first motion of primordial atoms, the upward motion of gaseous particles, the movement of iron towards the magnet, capillary motion as of liquid particles from the root to the stem of a plant, etc. The idea attached to the hypothesis of Adrista (which simply means "unseen") seems to have been modified in the course of time. Originally it would appear to have been used as an expression for agnosticism, no transcendental interpretation being attached to it. The chapter next treats of force; the causes of pressure, and of impact; gravity; curvilinear, vibratory, and rotatory motion; fluidity and the motion of fluids; measurement of motion; units of time and space; relative and serial motion. The author shows no inclina-

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tion to see anticipations which are not strictly legitimate. He points out that the Vaisesika theory of motion made only a distant approach to Newton's first law of motion, and that whilst a good foundation was laid for the explanation of the accelerated motion of falling bodies, Galileo's discovery was not anticipated. But there would seem reason to believe that Vâchaspati laid the foundations of solid geometry eight centuries before Descartes, and that Bhâskara (1150 A.D.), in computing planetary motion, appears to have used the differential calculus.

Ancient ideas on acoustics have a remarkable similarity to modern theories. It was recognised that the air was the physical basis of audible sound, and that its propagation was to be conceived on the analogy of waves in water. Various views, however, seem to have been held concerning the precise nature of the air-waves, as to the character of the vibratory movement, and how the molecules of a vibrating bell communicate their motion to the contiguous air-molecules. Echo was supposed to be a reflection of sound as an image in a mirror is a reflection of light. Attempts were made to explain pitch, intensity, and timbre by differences in the characteristics of the air-waves. The nature of musical sounds and intervals was the subject of acute speculation. Medieval compilations explain musical tones and their relations with reference to melody, as harmony was altogether unknown.

The wonderful plant-life of India naturally stimulated attempts at classification, and a short account of the various systems attributed to Charaka, Prasastapâda, Amara, and others is included in chapter iv. A section is devoted to elementary ideas of plant physiology, characteristics of plant-life, sexuality, and consciousness. It is a curious and suggestive chapter, not without interest to the modern plant-physiologist.

Not less interesting are the early Hindu attempts at the classification of animals based upon mode of origin—whether placental, oviparous, from moisture and heat, or from vegetable organisms. Snakes naturally received much attention, and elaborate accounts are given of the action of the poison of the several venomous families. This is one of the longest chapters in the book, and the accounts of the various systems are given in considerable detail.

Space precludes any attempt to give any description of ancient Hindu ideas concerning physiology and biology. Naturally, the phenomena of metabolism, of the circulatory system, and of the vascular and nervous system; of the seat of consciousness; of fœtal development; sex; heredity, received attention, and were the subject of speculation, often based upon acute and accurate observation, always interesting, and frequently highly suggestive. But enough has been stated to show that Dr. Brajendranath Seal has given us a most valuable contribution to the history of science by means of a work which must have involved a vast amount of study and research into a literature which is practically inaccessible to European students of physical science.

BRITISH FRESH-WATER RHIZOPODS.

The British Fresh-water Rhizopoda and Heliozoa. By J. Cash and G. H. Wailes. Vol. iii. *Rhizopoda.* Part iii. By G. H. Wailes. Pp. xxiv + 156 + plates xxxiii + lvii. (London: Ray Society, 1915.) Price 12*s.* 6*d.* net.

To say that the volume before us equals, if it does not surpass, its predecessors, not only in scientific value but in general construction, is to award it the highest praise. With the completion of their task by the publication of the concluding volume it will not be too much to state that what Leidy has done for the fresh-water Rhizopoda of North America the authors of this work will have done for the group in Great Britain. Since the publication of the second volume (in 1908) the senior author, James Cash, has died, and a sympathetic biography forms a fitting introduction to this volume from the hand of Mr. John Hopkinson, who, as is well known, rendered him material assistance in the preparation of vol. ii., and to whom the present instalment is indebted for a series of synonymies which may well serve as a pattern for all systematists, and may be said to constitute a practically complete bibliography of the subject.

The volume furnishes a very extended addition to our knowledge of the distribution of these organisms in the British Isles, especially by the incorporation of the splendid results of the labours of Mr. G. H. Wailes (which were embodied in his monograph of the group published in the reports of the Clare Island Survey), who now joins Mr. Hopkinson as one of the authors of this book. By the addition to the British list of Paulinella and Clypeolina, and the representation of Gromia by Allogromia and Rhynchogromia, the number of fresh-water Rhizopoda recorded as British is raised from forty-seven to fifty. The confused species *Euglypha alveolata* is divided into *E. acanthophora* and *E. tuberculata,* a simplification which will be welcomed by students of the group, supported as it is by a remarkable synonymy comprising no fewer than 157 well-considered references.

The authors direct attention to the specialised method of collecting reserve scales by *E. cristata,* and the contrivance by which the apex of the test is closed in *E. mucronata.* The new classification of the Gromiinæ will appeal as much to students of the marine as of the fresh-water Rhizopoda. In this section the preoccupied name Pamphagus is replaced by Lecythium, as the outcome of a laborious study of the existing synonymies. We do not agree with Rhumbler (who is followed by the authors) that Dujardin failed to notice the anastomosing reticulations of the pseudopodia of *Gromia oviformis;* his four papers published in 1835 (Ann. Sci. Nat., 1835, "Infusoires," 1841) make the contrary view clear, but for taxonomical purposes Rhumbler's sub-family, Allogromia, is undoubtedly useful. An interesting account is given of the reproductive processes of *Microgromia socialis,* as also of the indifferently marine or fresh-water genera, Lieberkuehnia and Rhyn-

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